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(71)Applicant : MITSUBISHI CHEMICALS CORP

(72)Inventor : KIYOMI KAZUMASA
SHIMOYAMA KENJI

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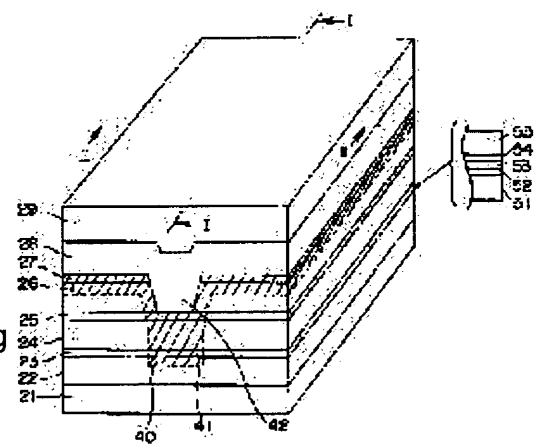
(54) SEMICONDUCTOR OPTICAL DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a semiconductor optical device which has a self-aligned inner stripe laser structure and does not receive COD even at high-output time by maintaining a low threshold current and high efficiency and a method of manufacturing the device.

SOLUTION: The semiconductor optical device has a first-conductivity clad layer 22, an active layer 23, a first second-conductivity clad layer 24, and a current blocking layer 26 having an opening 42 successively formed on a substrate 21 and a second second-conductivity clad layer 28 which is formed in the opening 42 and at least on part of the current blocking layers 26 on both sides of the opening. The band gap of the active layer 23 at both end sections of an optical waveguide is made larger than that of the layer 23 in a current injecting area at the center of the optical waveguide by performing heat treatment after impurity diffusion is made through ion implantation.



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DETAILED DESCRIPTION

16,17,18,19,20,21,22

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to reliable semi-conductor light device equipment especially in high power actuation about semi-conductor light device equipment useful as semiconductor laser, an amplifier, etc.
[0002]
[Description of the Prior Art] Although the semiconductor laser component which is one of the semi-conductor light device equipment is widely used from properties, such as the half-solidity, efficient, large wavelength selection range, and endurance, if an optical output becomes large, it will produce optical damage (henceforth "COD" (Catastrophic Optical Damage)) in an optical output end face, and will lose laser oscillation.
[0003] That COD at the time of such high power should be prevented, it divides roughly and two semiconductor laser components are developed. One is broadcloth area laser and it is the semiconductor laser component which can make an optical consistency low and can prevent generating of COD by enlarging a luminescence field. However, since this broadcloth area laser has the large luminescence field, it is difficult to make it operate by the optical output by which the single mode was stabilized.
[0004] Another is the laser component which established the non-absorbing field which does not absorb light substantially in the end face, and since the part of the reflecting mirror of an end face serves as a non-absorbing field (NAM field), it is usually called NAM laser (Non-Absorbing Mirror). It is possible for NAM laser to be able to prevent the light absorption in an end face, and to control COD completely. Moreover, without being restricted like [in the case of broadcloth area laser], with the non-absorbing field of an end face, since the structure near a barrier layer where induced emission is performed can be designed freely independently, it has the advantage which can be operated by the high optical output of a single mode.
[0005] From this advantage, it is a quantum well structure disordering process (H. Nakashima et al., Japanese Journal of Applied Physics, vol.24, No.8, L647 (1985), barrier layer embedded process in (2) edge field (H. the example of production (1989) of Naito et al., IEEE Journal Quantum Electronics, vol.QE-25, 1495, etc. is known.)) in (1) edge field as NAM laser until now. Although similarly the laser which made the edge un-absorbing by name called window structure laser in the U.S. Pat. No. 4,639,275 specification; U.S. Pat. No. 4,845,725 specification; U.S. Pat. No. ~~4,875,216~~ specification is developed, how these also mixed-crystal-ize quantum well structure by the impurity diffusion to a barrier layer is used.
[0006]
[Problem(s) to be Solved by the Invention] In the example of production of the above (1), in order to use impurity diffusion or vacant lattice diffusion of a configuration element, there is an advantage that a production process becomes easy. However, since an internal loss increases with the high-concentration impurity inside a barrier layer in the case of impurity diffusion, and an elevated-temperature process is comparatively required when it is vacant lattice diffusion of a configuration element, we are anxious about the process damage to a barrier layer. Moreover, although the outstanding laser property is realizable in the example of production of the above (2), there is a fault that the structure and the production process of a semiconductor laser component become complicated.
[0007] Thus, the aperture structure laser component which has the ridge structure produced using the quantum well structure disordering process in an edge field as an example of production of the above (1) is developed, and high power laser with high COD level is realized. For example, the aperture structure laser component which has ridge structure is indicated by JP,10-290043,A. The aperture structure laser component which has such conventional ridge structure forms the 1st conductivity-type cladding layer, a barrier layer, and the 2nd conductivity-type cladding layer on a substrate, diffuses an impurity to an edge field including a laser beam outgoing radiation side, and is formed by making a barrier layer mixed-crystal-ize. For this reason, in order to control the leakage current in an edge, it has quite complicated

structure.
[0008] The self aryne mold inner stripe laser component for which a current constriction field has order mesa-like structure is also developed to the semiconductor laser component of the above-mentioned ridge mold. This self aryne mold inner stripe laser component has fundamentally the advantage that a component is easily producible, from it being possible to produce by two crystal growth and one wet etching. However, it was simple until now and repeatability was not able to produce self aryne mold inner stripe laser highly efficient enough by the high approach.
[0009] In the aforementioned approach (JP,10-290043,A) of diffusing an impurity in an edge field including a laser beam outgoing radiation side on the other hand, making mixed-crystal-ize a barrier layer, and controlling COD, it was difficult to control diffusion of an impurity. Therefore, it is significant to develop the semi-conductor light device equipment which can control diffusion of an impurity, and its manufacture approach.
[0010] Let it be the offering-highly efficient semi-conductor light device equipment which does not receive COD in high power purpose in this way, this invention being made in view of the trouble of the above-mentioned conventional technique, and maintaining a low threshold current and a well head. Moreover, this invention aims also at offering the semi-conductor light device equipment [it is simple and] which can be manufactured according to the process that repeatability is high. Furthermore, this invention aims at offering the manufacture approach of semi-conductor light device equipment that leakage current and the internal loss in an edge field can be reduced.
[0011]
[Means for Solving the Problem] In order that this invention persons may solve the above-mentioned technical problem, as a result of advancing examination wholeheartedly, a substrate, The 1st conductivity-type cladding layer formed on this substrate, the barrier layer which has the quantum well structure formed on this 1st conductivity-type cladding layer, The 1st cladding layer of the 2nd conductivity type formed on this barrier layer, the current block layer which has opening formed on this 1st cladding layer of the 2nd electric conduction, It has this interior of opening, and the 2nd cladding layer of the 2nd conductivity type formed in the part on the current block layer of opening both the sides at least. The band gap of said barrier layer in a part for the both ends of optical waveguide by the ion implantation and heat treatment The semi-conductor light device equipment of this invention characterized by being larger than the band cap of said barrier layer in the current impregnation field of the center of optical waveguide found out that expected effectiveness was shown.
[0012] In production of the aperture structure laser which enlarged the band gap of the barrier layer in the edge of optical waveguide especially After carrying out an ion implantation by using self aryne mold inner stripe laser structure as the base so that the peak of an impregnation profile may come to a front-face side rather than a barrier layer, by heat-treating The increment in an internal loss [in an edge] could be controlled, or leakage current reduction in an edge could be aimed at, and it found out that the outstanding semi-conductor luminescence equipment in which expected effectiveness is shown was obtained.
[0013] Moreover, the process a at which this invention forms in this order the current block layer which has a substrate, the 1st conductivity-type cladding layer, a barrier layer, the 1st cladding layer of the 2nd conductivity type, and opening The process b which carries out heat treatment and forms an aperture structure field after [this opening] carrying out the ion implantation of the impurity to both ends at least The manufacture approach of the device equipment from a semi-conductor characterized by having this interior of opening and the process c which forms the 2nd cladding layer of the 2nd conductivity type in the part on the current block layer of opening both the sides at least is offered.
[0014] As a desirable mode of the semi-conductor light device equipment in this invention The mode which has the band gap from which the barrier layer in a part for the both ends of optical waveguide becomes transparent to the light generated in the barrier layer in the current impregnation field of the center of optical waveguide; the refractive index of a current block layer A mode smaller than the refractive index of the 2nd cladding layer of the 2nd conductivity type; a current block layer Opening The mode by which a current is poured into a barrier layer from mode; opening which consists of the 1st

conductivity type or a semi-conductor layer of high resistance at least; to both ends The mode used as the light source for mode; optical-fiber amplifier excitation which is opening which the other-end section is not elongating although mode; opening which is opening of the shape of a stripe currently elongated is developing to one edge; the mode used as an optical-fiber amplifier is mentioned.
[0015] moreover, as a desirable mode of the manufacture approach of the semi-conductor light device equipment in this invention The mode whose mode; aforementioned surface protective coat including the process which forms a surface protective coat in the front face of the part which does not carry out an ion implantation in said process b before carrying out an ion implantation, and removes this surface protective coat after an ion implantation is SiNx; In said process b mode; which removes this coating layer after forming a coating layer in said opening and said front face of the current block layer of opening both the sides and heat-treating before heat-treating -- said coating layer -- Si system -- since amorphous, the becoming mode is mentioned.
[0016]
[The mode of implementation of invention] The semi-conductor light device equipment and its manufacture approach of this invention are explained below at a detail. The 1st conductivity-type cladding layer by which the semi-conductor light device equipment of this invention was formed on the substrate and this substrate, The barrier layer which has the quantum well structure formed on this 1st conductivity-type cladding layer, The 1st cladding layer of the 2nd conductivity type formed on this barrier layer, the current block layer which has opening formed on this 1st cladding layer of the 2nd conductivity type, It has this interior of opening, and the 2nd cladding layer of the 2nd conductivity type formed in the part on the current block layer of opening both the sides at least. By the ion implantation and heat treatment The band gap of said barrier layer in a part for the both ends of optical waveguide is characterized by being larger than the band cap of said barrier layer in the current impregnation field of the center of optical waveguide. The semi-conductor light device equipment of this invention may have suitably the layer usually formed in the semi-conductor light device equipment other than these layers.
[0017] In this specification, the expression "the B horizon formed on the A horizon" contains, in case [both] one or more layers are formed in the top face of an A horizon and the B horizon is further formed on the layer, the case where the B horizon is formed so that the base of a B horizon may touch the top face of an A horizon, and. Moreover, the top face of an A horizon and the base of a B horizon have touched partially, and in other parts, also when one or more layers exist between an A horizon and a B horizon, it is contained in the above-mentioned expression. About a concrete mode, it is clear from explanation of following each class, and the example of an example.
[0018] Drawing 1 is the perspective view of an example of the semi-conductor light device equipment in this invention, drawing 2 is the cross section of said example, and is the I-I line cross section of drawing 1 , and drawing 3 is the cross section of said example, and is the II-II line cross section of drawing 1 . The structure of an example of semi-conductor light device equipment has the current block layer 26 and the cap layer 27 by which carried out the laminating of the 1st conductivity-type cladding layer 22, a barrier layer 23, and the 1st cladding layer 24 of the 2nd conductivity type on the substrate 21 which consists of a compound semiconductor, and opening was roughly carried out to the shape of a stripe through the etching blocking layer 25 on it. The 2nd cladding layer 28 of the 2nd conductivity type is formed so that a laminating may be carried out on the part in which the current block layer 26 furthermore carried out opening, and the current block layer of both the side, and the contact layer 29 is formed on the 2nd cladding layer 28 of the 2nd conductivity type.
[0019] In the semi-conductor light device equipment of this invention, the window region 40 by which the band gap of said barrier layer 23 was made larger than the band gap of the barrier layer 23 in the current impregnation field of the center of optical waveguide in a part for the both ends of optical waveguide is formed. This window region 40 is a field as for which disordering was carried out by the ion implantation, and the end face of the optical waveguide of a barrier layer 23 consists of mixed-crystal fields 41. The field shown with a slash in drawing 3 from drawing 1 is a field where the ion implantation was made. Usually, since a barrier layer 23 has duplex quantum well (DQW) structure, it shows a band gap like drawing 5 (b), but since disordering of the window region 40 is carried out by the

ion implantation, as shown in drawing 5 (a), it is larger than the band gap of the usual barrier layer 23. For this reason, with the semi-conductor light device equipment of this example, absorption of a light wave is controlled in an optical output end face, and COD can be prevented beforehand.

[0020] Moreover, the 2nd cladding layer 28 of the 2nd conductivity type reaches interior of opening 42, and the semi-conductor light device equipment of this invention is formed in the part on the current block layer 26 of the 42 openings side at least (self aryne mold inner stripe laser structure). For this reason, there are advantages, like that there are few counts of growth and they end compared with the ridge mold structure indicated by JP,10-290043,A and the special technique of selective growth is needlessness (the selective growth of the compound containing many especially aluminum is difficult) in the structure of this invention.

[0021] In drawing 1 , a substrate 21 will not be limited especially about the conductivity or ingredient, if it is possible to grow up the crystal of terrorism structure to be double on it. A desirable thing is a substrate with conductivity. It is desirable to specifically use GaAs suitable for crystal thin film growth of a up to [a substrate], InP and GaP, ZnSe, ZnO and Si, the crystal substrate of aluminum2O3 grade, especially the crystal substrate that has zincblende structure. In that case, low ****** or the field equivalent to it and a crystallography target of a substrate crystal growth side is desirable, and it is the most desirable. [of a field (100)] In addition, when calling it a field (100) in this specification, it is not necessary to be necessarily the field of JASUTO strictly (100), and even when it has an about 30 degrees [a maximum of] off angle type, it includes. The upper limit of the magnitude of an off angle type has desirable 30 degrees or less, and is more desirable. [of 16 degrees or less]

[0022] Moreover, a substrate 21 can also use the substrate which the substrate of a hexagonal mold is sufficient as, for example, consists of aluminum 2O3, 6 H-SiC, etc.

[0023] In order not to usually carry in the defect of a substrate on a substrate 21 at an epitaxial growth phase, it is desirable to form a buffer layer with a thickness of about 0.2-2 micrometers.

[0024] On a substrate 21, the compound semiconductor layer containing a barrier layer 23 is formed. The compound semiconductor layer contains the layer with a refractive index smaller than a barrier layer of a barrier layer up and down, among those, in the layer by the side of a substrate, the 1st conductivity-type cladding layer and the layer by the side of epitaxial of another side function as the 2nd conductivity-type cladding layer. The size relation of these refractive indexes can be adjusted by choosing the ingredient presentation of each class as this contractor suitably according to a well-known approach. For example, a refractive index can be adjusted by changing aluminum presentation of AlxGa1-xAs, 0.5(AlxGa 1-x) In0.5P, AlxGa1-xN, etc.

[0025] The 1st conductivity-type cladding layer 22 is formed with an ingredient with a refractive index smaller than a barrier layer 23. Moreover, as for the refractive index of the 1st conductivity-type cladding layer 22, it is desirable that it is larger than the refractive index of the 2nd conductivity-type cladding layer. For example, common III-V groups, such as InP of the 1st conductivity type, GaInP, AlGaInP, AlInP, AlGaAs, AlGaAsP, AlGaInAs, GaInAsP, GaN, AlGaN, AlGaInN, BeMgZnSe, MgZnSSe, CdZnSeTe, ZnO, MgZnO, and MgO, and an II-VI group semi-conductor can be used. As for the carrier concentration of the 1st conductivity-type cladding layer 22, three or more [1x1017cm -] are desirable, three or more [3x1017cm -] are more desirable, and three or more [5x1017cm -] are [a minimum] ~~the most desirable. As for~~ an upper limit, three or less [2x1020cm -] are desirable, three or less [5x1019cm -] are more desirable, and three or less [5x1018cm -] are the most desirable.

[0026] The 1st conductivity-type cladding layer 22 may consist of a monolayer, and may consist of a layer more than two-layer. When consisting of a monolayer, as for the minimum of thickness, it is desirable that it is 0.4 micrometers or more, it is more desirable that it is 0.6 micrometers or more, and it is desirable that it is especially 0.7 micrometers or more. As for the upper limit of thickness, it is desirable that it is 5.0 micrometers or less, it is more desirable that it is 3.0 micrometers or less, and it is desirable that it is especially 2.0 micrometers or less.

[0027] The 1st conductivity-type cladding layer 22 may consist of two or more layers, and can specifically illustrate the mode in which the cladding layer which consists of GaInP, AlGaInP, or AlInP, and the cladding layer which is from AlGaAs or AlGaAsP of the 1st conductivity type on a substrate 21

side rather than the layer are formed to a barrier layer side. At this time, as for the thickness of the layer by the side of a barrier layer 23, it is desirable to make it thin, its 0.01 micrometers or more are desirable as a minimum of thickness, and its 0.05 micrometers or more are more desirable. As an upper limit, 0.5 micrometers or less are desirable and 0.3 micrometers or less are more desirable. Moreover, as for the carrier concentration of the layer by the side of a substrate 21, three or more [2x1017cm -] are desirable, and three or more [5x1017cm -] are [a minimum] more desirable. As for an upper limit, three or less [2x1020cm -] are desirable, and three or less [5x1019cm -] are more desirable.

[0028] Especially the structure of the barrier layer 23 which constitutes the semi-conductor light device equipment of this example is not restricted, but has duplex quantum well (DQW) structure in an example of drawing 1 . This duplex quantum well (DQW) structure specifically has the structure which carried out the laminating of the optical confinement layer (non dope) 51, the quantum well layer (non dope) 52, the barrier layer (non dope) 53, the quantum well layer (non dope) 54, and the confining layer (non dope) 55 one by one. You may be the multiple quantum well structure of having the optical confinement layer by which the laminating was carried out to the single quantum well structure (SQW) which consists of an optical confinement layer for example, a quantum well layer and said whose quantum well layer are pinched from the upper and lower sides besides this duplex quantum well (DQW) structure, and the barrier layer list inserted into a three or more-layer quantum well layer and them on the best quantum well layer and under the lowest quantum well layer. By making a barrier layer 23 into quantum well structure, short-wavelength-izing and low threshold-ization can be attained as compared with the bulk barrier layer of a monolayer.

[0029] As an ingredient of a barrier layer 23, common III-V groups, such as GaAs, GaInAs, GaInP, GaInAsP, GaN, GaInN, GaNAs, GaNP, ZnSe, ZnSSe, CdZnSeTe, ZnO, and CdZnO, and an II-VI group semi-conductor can be used, for example. Since natural superlattice is easy to be formed when it is the ingredient which contains especially Ga and In as a configuration element, the effectiveness of the natural superlattice control by using an off substrate becomes large. In addition, as for the barrier layer in a part for the both ends of optical waveguide, it is desirable to have the band gap which becomes transparent to the light generated in the barrier layer in the current impregnation field of the center of optical waveguide. When the barrier layer 23 has quantum well structure, it is desirable to adopt the following modes from a viewpoint of the ease of mixed-crystal-izing.

(1) When the what (2) barrier layer the barrier layer has the single well layer for since variation of a presentation before and after mixed-crystal-izing can be enlarged (single quantum well) has two or more well layers (multiplex quantum well), In order to enlarge band gap change before and after the formation of thing (3) mixed crystal with the thickness of the barrier layer pinched by the mixed-crystal presentation well layer larger in order to control reduction of the band gap near a mixed-crystal-ized field center than a well layer A containing [in the configuration element of the barrier layer whose containing / in the configuration element of a starting / compressive strain /-well layer (4) well layer / In which is comparatively easy to diffuse at low temperature / (5) well layer is pinched, or a guide layer / In which makes a band gap small] (6) well layer Thing [0030] by which aluminum which enlarges a band gap is contained in the configuration element of the barrier layer to pinch or a guide layer The 2nd conductivity-type cladding layer is formed on a barrier layer 23. The 2nd conductivity-type cladding layer of this invention is formed more than two-layer. The following explanation explains taking the case of the desirable mode which has two-layer [of the 1st cladding layer 24 of the 2nd conductivity type, and the 2nd cladding layer 28 of the 2nd conductivity type] sequentially from the direction near a barrier layer 23.

[0031] The 1st cladding layer 24 of the 2nd conductivity type is formed with an ingredient with a refractive index smaller than a barrier layer 23. For example, common III-V groups, such as InP of the 2nd conductivity type, GaInP, AlGaInP, AlInP, AlGaAs, AlGaAsP, AlGaInAs, GaInAsP, GaN, AlGaN, AlGaInN, BeMgZnSe, MgZnSSe, CdZnSeTe, ZnO, MgZnO, and MgO, and an II-VI group semi-conductor can be used. When the 2nd conductivity-type cladding layer consists of groups III-V semiconducter containing aluminum, since scaling can be prevented if the whole substantial surface in which the growth is possible is covered by the group III-V semiconducter who does not contain

aluminum, such as GaAs, GaAsP, GaInAs, GaInP, and GaInN, it is desirable.
[0032] As for the carrier concentration of the 1st cladding layer 24 of the 2nd conductivity type, three or more [1x1017cm -] are desirable, three or more [3x1017cm -] are more desirable, and three or more [5x1017cm -] are [a minimum] the most desirable. As for an upper limit, three or less [5x1018cm -] are desirable, three or less [3x1018cm -] are more desirable, and three or less [2x1018cm -] are the most desirable. Moreover, the thickness of the 1st cladding layer 24 of the 2nd conductivity type has desirable 0.01 micrometers or more as a minimum, its 0.05 micrometers or more are more desirable, and its 0.07 micrometers or more are the most desirable. As an upper limit, 0.5 micrometers or less are desirable, 0.4 micrometers or less are more desirable, and 0.2 micrometers or less are the most desirable.

[0033] The 1st cladding layer 24 of the 2nd conductivity type is formed on a barrier layer 23. The refractive index of the 1st cladding layer 24 of the 2nd conductivity type can also be made smaller than the refractive index of the 1st conductivity-type cladding layer 22. If it does in this way, it will become possible to control optical distribution (near-field pattern) so that light oozes out from a barrier layer effectively to a lightguide layer side. Moreover, since the photoconductive wave loss to an ion-implantation field from an active region (part in which a barrier layer exists) can also be reduced, improvement in the laser property in high power actuation or dependability can be attained.
[0034] By forming the etching blocking layer 25 on the 1st cladding layer 24 of the 2nd conductivity type, corrosion with the etching reagent of the 1st cladding layer 24 of the 2nd conductivity type at the time of etching processing can be prevented. Moreover, if it has the etching blocking layer 25, in case the 2nd cladding layer 28 of the 2nd conductivity type will be re-grown up into opening 42 at least, generating of a high resistive layer which increases passage resistance by the re-growth interface can be prevented easily.
[0035] If the ingredient of the etching blocking layer 25 is what has resistance to an etching reagent at the time of etching processing, i.e., the thing which is not corroded, there will be especially no limitation. Moreover, the ingredient of the etching blocking layer 25 may have the antioxidizing function besides a corrosion prevention function simultaneously. Specifically, AlXGa1-XAs (0<=X<=1), lnYGal-YP (0<=Y<=1), etc. are mentioned.
[0036] The thickness of the etching blocking layer 25 is chosen so that a band gap may generally become large rather than the ingredient of a barrier layer 23, its 50nm or less is desirable as the upper limit, and its 20nm or less is more desirable. As a minimum, 2nm or more is desirable and 5nm or more is more desirable.
[0037] When there is especially no limit when the conductivity type of the etching blocking layer 25 is removed from the interior of a slot by etching, and a layer is formed in the interior of a slot, the 2nd conductivity type is desirable. Moreover, as for the etching blocking layer 25, it is desirable to carry out lattice matching to a substrate if possible. Furthermore, it is desirable by choosing an ingredient and thickness suitably to make it not absorb the light from a barrier layer 23.
[0038] The current block layer 26 which constitutes the semi-conductor light device equipment of this invention is formed on the 1st cladding layer 24 of the 2nd conductivity type, and has opening 42. Fundamentally, a current is poured into a barrier layer from this opening 42.
[0039] The ingredient of the current block layer 26 will not be limited especially if it is a semi-conductor. When a semi-conductor is used as an ingredient of the current block layer 26, since cleavability with sufficient heat dissipation nature is good since the heat conductivity is high, and it is easy to carry out flattening as compared with a dielectric film and it easy to form an assembly, a cone, and a contact layer by junction down in the whole surface, there is an advantage, such as being easy to lower contact resistance.
[0040] The refractive index of the current block layer 26 is made lower than the refractive index of the 2nd cladding layer 28 of the 2nd conductivity type which consists of AlGaAs or AlGaAsP inserted into the current block layer 26 (real refractive-index guide structure). By controlling such a refractive index, it becomes possible to reduce the operating current compared with the conventional loss guide structure. When the current block layer 26 of the refractive-index difference of the current block layer 26 and the

2nd cladding layer 28 of the 2nd conductivity type is a compound semiconductor, as for a minimum, 0.001 or more are desirable, 0.003 or more are more desirable, and 0.007 or more are the most desirable. As for an upper limit, 1.0 or less are desirable, 0.5 or less are more desirable, and 0.1 or less are the most desirable. When the current block layer 26 is a dielectric, as for a minimum, 0.1 or more are desirable, 0.3 or more are more desirable, and 0.7 or more are the most desirable. As for an upper limit, 3.0 or less are desirable, 2.5 or less are more desirable, and 1.8 or less are the most desirable.

[0041] When making the refractive index of the current block layer 26 into a low refractive index rather than the 2nd cladding layer 28 of the 2nd conductivity type and lattice matching with a GaAs substrate are taken into consideration, as for the ingredient of the current block layer 26, it is desirable to use the semi-conductor of AlGaAs, AlGaAsP, AlGaInP, or AlInP. If deposition prevention (HCl addition selective growth) of Pori to the protective coat at the time of selective growth can be performed, it is more desirable to choose AlGaAs or AlGaAsP, since AlGaInP or AlInP has the instability of change of the refractive index by the formation of natural superlattice with bad heat conduction and In presentation in selective growth (order mesa-like an opening side attachment wall and a base) etc. compared with AlGaAs or AlGaAsP. However, since in AlGaAs or AlGaAsP deliquescence is shown when aluminum presentation becomes close to AlAs too much, as for the upper limit of aluminum presentation, 0.95 or less are desirable, 0.90 or less are more desirable, and 0.80 or less are the most desirable. As for the minimum of aluminum presentation from it being necessary to make it a low refractive index, 0.35 or more are desirable, 0.37 or more are more desirable, and 0.4 or more are the most desirable than the 2nd conductivity-type cladding layer.

[0042] In order that the current block layer 26 may control optical distribution (especially lateral optical distribution) or may raise the function of current inhibition, it may be formed from two or more layers from which a refractive index, carrier concentration, or a conductivity type differs. The cap layer 27 can be formed on the current block layer 26, and control of scaling or the surface protection on a process can be planned. Although especially the conductivity type of the cap layer 27 is not specified, improvement in a current inhibition function can be aimed at by considering as the 2nd conductivity type.

[0043] The conductivity types of the current block layer 26 may be any of these [the 1st conductivity type, high resistance (the impurities (O, Cr, Fe, etc.) which form undoping or deep ranking are doped), or] two combination, and may be formed from two or more layers from which a conductivity type or a presentation differs. For example, the current block layer currently formed from the side near a barrier layer 23 in order of the 2nd conductivity type or the semi-conductor layer of high resistance, and the semi-conductor layer of the 1st conductivity type can be used preferably. Moreover, since trouble may be produced in current inhibition if not much thin, as for thickness, it is desirable that it is 0.1 micrometers or more, and it is more desirable that it is 0.3 micrometers or more. On the other hand, if too thick, in order to cause increase of passage resistance, 2 micrometers or less of an upper limit are desirable, and it is more desirable. [of 1 micrometer or less] If the size as a semiconductor laser component etc. is taken into consideration, it is desirable to choose from the range of about 0.3-1 micrometer.

[0044] as the top layer of the current block layer 26 -- the opening 42 interior -- and the 2nd cladding layer 28 of the 2nd conductivity type is formed so that it may result in the part on the current block layer 26 of the 42 openings side at least. The 2nd cladding layer 28 of the 2nd conductivity type is formed so that all the top front faces of opening 42 may be covered and it may extend at least in the part on the current block layer 26 of both the sides of opening 42. Since the window region 40 formed of the ion implantation mentioned later was formed in the comparatively narrow range for both ends of optical waveguide in self align, and it formed so that the 2nd cladding layer 28 of the 2nd conductivity type might extend to the part on the current block layer 26 of both the sides of opening 42, using the current block layer 26 as it is, a component property can fully be stabilized.

[0045] The window region 40 in the semi-conductor light device equipment of this invention is producible by carrying out heat treatment and forming an aperture structure field, after carrying out the ion implantation of the impurity to the compound semiconductor layer formed above the barrier layer 23. The impurity (ion source) diffused in production of window region 40 will not have limitation,

especially if it functions as a dopant. For example, Si, F, aluminum, B, C, N, P, S, As, and Ga can be mentioned. Si, F, B, C, N, P, and As are more desirable, Si, F, B, and N are still more desirable, and Si is the most desirable.

[0046] The semi-conductor light device equipment which has the configuration of this invention is the upper part of a barrier layer 23, and can perform impurity diffusion by the ion implantation from the part where the distance from a barrier layer is comparatively short. For example, with an example shown in drawing 1 , an impurity can be diffused by carrying out an ion implantation from the cap layer 27, respectively at a part for the both ends of optical waveguide in a part for the both ends except the etching blocking layer 25 and optical waveguide. In a part for the both ends of optical waveguide, an impurity can be attained to a barrier layer 23 through the etching blocking layer 25 with comparatively thin thickness, and the 1st cladding layer 24 of the 2nd conductivity type. For this reason, improvement in the position control nature of an ion-implantation front and leakage current reduction in an edge can be aimed at easily. Moreover, in a part for the both ends except optical waveguide, it can reach in the current block layer 26 under it through the cap layer 27.

[0047] If there are too few injection rates (the amount of DOSU) of the ion in the case of carrying out an ion implantation, mixed-crystal-ization of a barrier layer will stop being able to happen easily. There is a problem of the high impurity concentration in a barrier layer becoming high too much on the other hand if many [too], or becoming easy to be influenced of degradation by the quality by the re-growth interface, and causing the fall of the controllability of a front location and the increment in the leakage current in an edge. If an impurity is especially spread to the layer with a comparatively small band gap below the 1st conductivity-type cladding layer 22, the increment in leakage current will become large and will spoil the engine performance as a light emitting device greatly.

[0048] When these are taken into consideration, as for the ion injection rate in the case of carrying out an ion implantation (the amount of DOSU), two or more [0.1x1013cm -] are desirable as a minimum, two or more [0.5x1013cm -] are more desirable, and two or more [0.7x1013cm -] are the most desirable. As an upper limit, two or less [20x1013cm -] are desirable, two or less [15x1013cm -] are more desirable, and two or less [10x1013cm -] are the most desirable.

[0049] Usually, the ion-implantation profile to the inside of a solid-state is [/ especially near the peak] very well in agreement with Gaussian distribution. When a dose was set constant by artificers' examination result and the peak location became deep [in view of a front-face side] even at back from it near the barrier layer, in the dose with more nearly same setting up an impregnation profile so that mixed-crystal-ization may stop being able to happen easily and a peak location may come to a front-face side for a while rather than a barrier layer, it turned out that mixed-crystal-ization is promoted more. Moreover, in heat treatment after impregnation, in spite of having not spread the impregnation atom to a barrier layer side, it also turns out that mixed-crystal-ization takes place inside a barrier layer. Even if an impurity is not spread during heat treatment after an ion implantation from this, it is possible to make it mixed-crystal-ize. Although problems, such as light absorption (large increase of an internal loss) by the impurity in edge window region and an increment in the leakage current in the edge by the shift of a pn junction location, had occurred, since substantial impurity diffusion to a barrier layer is not needed, by this invention, the conventional trouble is solvable with the impurity diffusion to the conventional barrier layer.

[0050] As for the peak location of the viewpoint of the damage reduction to the ease of carrying out and barrier layer of mixed-crystal-izing from this to an impregnation profile, it is more desirable than a barrier layer that it is in a front-face side. Concretely, the distance from the peak location of an impregnation profile to a barrier layer has desirable 0.01 micrometers or more, and is [a minimum] more desirable. [of 0.03 micrometers or more] 0.2 micrometers or less of an upper limit are desirable, and it is more desirable. [of 0.1 micrometers or less]

[0051] In this invention, before carrying out the ion implantation of the impurity, a surface protective coat can be formed in the part which does not dope an impurity by the ion implantation. When forming a surface protective coat, the ingredient of a surface protective coat will not be especially limited, if the conditions of not penetrating a dopant at the time of an ion implantation are fulfilled. The group which

can specifically use a dielectric as a surface protective coat, for example, consists of the SiNx film, SiO2 film, the SiON film, 2Oaluminum3 film, the ZnO film, SiC film, and an amorphous silicon can be mentioned. It is the SiNx film preferably. When a surface protective coat is formed, before heat-treating, this surface protective coat is removed. If the method of removing this surface protective coat can remove this surface protective coat completely, there will be especially no limitation. Therefore, the etching approach usually used can be used, for example, dry etching, wet etching, reactive ion etching, plasma etching, etc. can be mentioned.

[0052] When performing mixed-crystal-ization, it is necessary to carry out the ion-implantation front in an opening edge below the quantum well layer in a barrier layer 23, and it is more desirable than a barrier layer 23 from a viewpoint of current leak control to form in the large 1st conductivity-type cladding layer 22 of a band gap.

[0053] Before formation of the window region by heat treatment of this invention, the front face of opening 42 and a current block layer can also be beforehand covered in a coating layer. When forming a coating layer, the ingredient of a coating layer will not be limited especially if it has thermal resistance, stability, etc. It is also possible to use AMORUFASU from a viewpoint of the ease of carrying out of thin film formation or processing, and, specifically, SiNx, SiO2, SiON, aluminum 2O3, ZnO, SiC, etc. are mentioned.

[0054] In addition, when a coating layer is formed, before forming the 2nd cladding layer 28 of the 2nd conductivity type, this coating layer is removed. If the method of removing this coating layer can remove this coating layer completely, there will be especially no limitation. Therefore, the etching approach usually used can be used, for example, dry etching, wet etching, reactive ion etching, plasma etching, etc. can be mentioned.

[0055] The approach of heat treatment in this invention will not be especially limited, if an aperture structure field can be formed after an ion implantation. Therefore, the approach used for the usual annealing can be used, for example, hydrogen annealing, rapid heat annealing (Rapid Thermal Anneal), a rapid heating process (Rapid Thermal Process), etc. are mentioned.

[0056] In heat treatment after an ion implantation, window region can be formed by adjusting the temperature and time amount of heat treatment. It is desirable that an upper limit is 1000 degrees C or less, as for the temperature of annealing of this invention, it is more desirable that it is 900 degrees C or less, and it is further more desirable that it is 850 degrees C or less. As a minimum, it is desirable that it is 600 degrees C or more, it is more desirable that it is 700 degrees C or more, and it is still more desirable that it is 800 degrees C or more. Moreover, it is desirable that an upper limit is 60 or less minutes, as for the time amount of annealing, it is more desirable that it is 30 or less minutes, and it is further more desirable that it is 15 or less minutes. Moreover, as a minimum of the time amount of annealing, it is desirable that it is 5 seconds or more, it is more desirable that it is 10 seconds or more, and it is still more desirable that it is 30 seconds or more.

[0057] As for the carrier concentration of the 2nd cladding layer 28 of the 2nd conductivity type, three or more [3x1017cm -] are desirable, three or more [5x1017cm -] are more desirable, and three or more [7x1017cm -] are [a minimum] the most desirable. Moreover, as for an upper limit, three or less [1x1019cm -] are desirable, three or less [5x1018cm -] are more desirable, and three or less [3x1018cm -] are the most desirable.

[0058] If it will become inadequate [optical confinement] if the thickness of the 2nd cladding layer 28 of the 2nd conductivity type becomes thin too much, and it becomes thick too much, passage resistance will increase it. For this reason, the minimum of the thickness of the 2nd cladding layer 28 of the 2nd conductivity type has desirable 0.5 micrometers or more, and its 1.0 micrometers or more are more desirable. 3.0 micrometers or less of an upper limit are desirable, and it is more desirable. [of 2.0 micrometers or less]

[0059] In forming an electrode further after forming the current block layer 26 and the 2nd cladding layer 28 of the 2nd conductivity type, in order to reduce contact resistance with an electrode material, it is desirable to form the contact layer 29 of low resistance (high carrier concentration). It is desirable to form an electrode, after forming the contact layer 29 in the whole maximum upper front face which is

going to form especially an electrode.
[0060] At this time, in order that the ingredient of the contact layer 29 may be chosen from ingredients with a band gap usually smaller than a cladding layer and may take ohmic nature with a metal electrode, it is desirable to have a suitable carrier consistency by low resistance. For example, common III-V groups, such as GaAs, GaInAs, GaInP, GaInAsP, GaN, GaInN, GaNAs, GaNP, ZnSe, ZnSSe, CdZnSeTe, ZnO, and CdZnO, and an II-VI group semi-conductor can be used. As for the minimum of a carrier consistency, three or more [1x1018cm -] are desirable, three or more [3x1018cm -] are more desirable, and three or more [5x1018cm -] are the most desirable. As for an upper limit, three or less [2x1020cm -] are desirable, three or less [5x1019cm -] are more desirable, and three or less [3x1019cm -] are the most desirable. As for a minimum, it is desirable that it is 0.1 micrometers or more, as for the thickness of the contact layer 29, it is more desirable that it is 0.3 micrometers or more, and it is desirable that it is especially 0.5 micrometers or more. It is desirable that it is 10 micrometers or less, as for the upper limit of thickness, it is more desirable that it is 6 micrometers or less, and it is desirable that it is especially 4 micrometers or less.
[0061] Next, the opening 42 formed in the current block layer 26 is explained.
[0062] The opening 42 of the current block layer 26 has the desirable direction where it is made for the direction below a top (contact layer 29 side) (barrier layer 23 side) to become small from a viewpoint of reduction (operating voltage and reduction of generation of heat) of passage resistance. By forming the current block layer 26 on an edge aperture structure field, the leakage current in an edge aperture structure field can be abolished. Moreover, the current impregnation to the edge of a barrier layer 23 can also be controlled by forming the current block layer 26 inside further rather than an edge aperture structure field. Thereby, degradation (especially end-face degradation) in an edge field can be reduced.
[0063] The opening 42 of the current block layer 26 may be opening of the shape of a stripe currently elongated to both ends, and although it is elongating to one edge, it may be opening which the other-end section is not elongating. When opening is opening of the shape of a stripe currently elongated to both ends, control of the light in an edge aperture structure field becomes easier, and the flare of the light of the longitudinal direction in an end face can be made small. While, preventing the recombination of the current in an end face on the other hand since a current can be made un-pouring in near an end face when opening is formed in the part which entered inside to some extent from the end face, a surroundings lump of the current from a cladding layer etc. can be minimized. As for the structure of opening, it is desirable to determine suitably according to the purpose of use, taking such an advantage into consideration.
[0064] From the direction which intersects perpendicularly in the direction (longitudinal direction) in which the opening 42 formed in the current block layer 26 is extended, the direction of an off angle type has a less than **30-degree desirable direction, is more desirable, and is the most desirable. [of a less than **2-degree direction] [of a less than **7-degree direction] Moreover, when field bearing of a substrate 21 is (100), the direction of opening 42 has a less than **30-degree desirable direction from the direction where the direction equivalent to [0-11] or it of the direction of an off-angle type is equivalent to the [011] directions or it, is more desirable, and is the most desirable. [of a less than **2-degree direction] [of a less than **7-degree direction] In addition, when calling it "[011] Direction" in this specification, in a common III-V group and an II-VI group semi-conductor, the [011] directions are defined as the field which exists between fields (100) (011) being a field where an III group or II group element appears, respectively.
[0065] The embodiment of this invention is not limited when the above-mentioned opening is the [01-1] direction. For example, when opening is extended in the [011] directions or the direction equivalent to it and a crystallography target, an anisotropy can be given to a growth rate, and it is quick in a field (100) and can avoid almost growing up by the Bth (111) page according to growth conditions. [011] By forming a stripe-like protective coat in a direction, the current block layer which makes the Bth (111) page a side face can be formed.
[0066] When the substrate of the Ur Die Zeit mold is used for the same reason, as for the direction where opening is extended, for example, (0001) on a field, [11-20] or [1-100] is desirable. Although

which direction is sufficient in HVPE (Hydride Vapor Phase Epitaxy), the [11-20] direction is more desirable in MOVPE.

[0067] It faces designing the semi-conductor light device equipment of this invention, and first, in order to acquire a desired perpendicular flare angle, the thickness of a barrier layer and the presentation of a cladding layer are determined. Usually, although it is set up straitness in comparison when high power actuation is needed since the light from a barrier layer to a cladding layer permeates, a broth is promoted, the optical consistency in an end face becomes small and the optical damage (COD) level of an outgoing radiation end face can improve if a perpendicular flare angle is narrowed A minimum has a limit by controlling the fall of the temperature characteristic by increase of the oscillation threshold current by reduction of the optical confinement in a barrier layer, and overflow of a carrier, 15 degrees or more of a minimum are desirable, its 17 degrees or more are more desirable, and its 19 degrees or more are the most desirable. 33 degrees or less of an upper limit are desirable, it is more desirable, and is the most desirable. [of 30 degrees or less] [of 31 degrees or less]

[0068] Next, if a perpendicular flare angle is determined, the structure parameter which governs a high power property greatly will serve as the width of face (henceforth "aperture width") W in the distance dp and the opening pars basilaris ossis occipitalis between a barrier layer and a current block layer. In addition, when only the 1st cladding layer of the 2nd conductivity type exists between a barrier layer and a current block layer, dp serves as thickness of the 1st cladding layer of the 2nd conductivity type. Moreover, when a barrier layer is quantum well structure, the distance of the barrier layer nearest to a current block layer and a current block layer is set to dp.

[0069] About dp, 0.50 micrometers or less of an upper limit are desirable, it is more desirable, and is the most desirable. [of 0.30 micrometers or less] [of 0.40 micrometers or less] 0.03 micrometers or more of a minimum are desirable, its 0.05 micrometers or more are more desirable, and its 0.07 micrometers or more are the most desirable. However, if the purposes of use, such as where to set up a flare angle, differ from ingredient systems (a refractive index, resistivity, etc.) etc., a little above-mentioned optimal range will also be shifted. Moreover, this optimal range also takes cautions for each above-mentioned structure parameter to influence each other for each other.

[0070] As for the aperture width W in an opening pars basilaris ossis occipitalis, it is desirable that an upper limit is 1000 micrometers or less, and it is more desirable that it is 500 micrometers or less. It is desirable that a minimum is 1 micrometers or more, it is more desirable that it is 1.5 micrometers or more, and it is most desirable that it is 2 micrometers or more. Moreover, in order to make the transverse mode into a single mode (longitudinal direction light intensity distribution of a single peak), W can seldom be enlarged from a viewpoint of the cut-off of the higher mode, and prevention of a spatial hole burning, but the upper limit of W has desirable 7 micrometers or less, and is more desirable, and especially 3 micrometers or less are desirable [an upper limit]. [of 5 micrometers or less]

[0071] Although it is effective from a viewpoint of the optical consistency reduction by the end face to make large aperture width W in an opening pars basilaris ossis occipitalis in order to realize high power actuation of 300mW or more of optical outputs, it is desirable from a viewpoint of waveguide loss reduction to narrow aperture width, in order to reduce the operating current. Then, by making comparatively narrow aperture width W2 near [used as a gain field] a center, and making the aperture width W1 near an edge become comparatively large, the low operating current and high power actuation can be realized to coincidence, and high dependability can also be secured (drawing 6 (a)). That is, about the edge (cleavage plane) width of face W1, it is desirable that an upper limit is 1000 micrometers or less, and although it is 500 micrometers or less, it is more desirable. As for a minimum, it is desirable that it is 2 micrometers or more, and it is more desirable that it is 3 micrometers or more. About the center-section width of face W2, it is desirable that an upper limit is 100 micrometers or less, and it is more desirable that it is 50 micrometers or less. As for a minimum, it is desirable that it is 1 micrometers or more, it is more desirable that it is 1.5 micrometers or more, and it is most desirable that it is 2 micrometers or more. About the difference of the edge width of face W1 and the center-section width of face W2, 1000 micrometers or less of an upper limit are desirable, and it is more desirable. [of 500 micrometers or less] About a minimum, 0.2 micrometers or more are desirable and 0.5 micrometers or

more are more desirable.
[0072] In order to make the transverse mode into a single mode furthermore, the upper limit of the edge width of face W1 has desirable 10 micrometers or less, and is more desirable. [of 7 micrometers or less] The upper limit of the center-section width of face W2 has desirable 7 micrometers or less, and is more desirable. [of 5 micrometers or less] About the difference of the edge width of face W1 and the center-section width of face W2, 5 micrometers or less of an upper limit are desirable, it is more desirable, and is the most desirable. [of 2 micrometers or less] [of 3 micrometers or less] About a minimum, 0.2 micrometers or more are desirable and 0.5 micrometers or more are more desirable.
[0073] In order for a beam to attain circularly near (two or less aspect value) laser, maintaining high dependability, it is necessary to dedicate Above dp and W with a controllability sufficient in the suitable range.
[0074] In order to realize a circularly near beam, it is effective to narrow aperture width, but when aperture width is narrowed, the consistency of an inrush current consistency does not have the viewpoint of bulk degradation control to good ****. Then, by making large comparatively center-section width of face W2 used as a gain field, and making near an edge become comparatively narrow, beam-spot reduction and the low operating current can be realized to coincidence, and high dependability can also be secured (drawing 6 (b)).
[0075] That is, about the edge (cleavage plane) width of face W1, it is desirable that an upper limit is 10 micrometers or less, and although it is 5 micrometers or less, it is more desirable, and it is most desirable that it is 3 micrometers or less. It is desirable that a minimum is 0.5 micrometers or more, and it is more desirable that it is 1 micrometers or more. About the center-section width of face W2, it is desirable that an upper limit is 100 micrometers or less, and it is more desirable that it is 50 micrometers or less. It is desirable that a minimum is 1 micrometers or more, it is more desirable that it is 1.5 micrometers or more, and it is most desirable that it is 2 micrometers or more. About the difference of the edge width of face W1 and the center-section width of face W2, 100 micrometers or less of an upper limit are desirable, and it is more desirable. [of 50 micrometers or less] About a minimum, 0.2 micrometers or more are desirable and 0.5 micrometers or more are more desirable.
[0076] Although what is necessary is just to design the die length of the above-mentioned gradual increase part or a gradual decrease part, and an edge according to a desired property, from a viewpoint of waveguide loss reduction, the die length of a gradual decrease part has desirable 5-10 micrometers respectively, and its 10-50 micrometers are more desirable. The die length of an edge has desirable 5-30 micrometers from a viewpoint of cleavage precision, and its 10-20 micrometers are more desirable. However, an aperture may be produced as follows if needed.
(1) That from which the aperture width or die length of an edge, a gradual increase part, or a gradual decrease part becomes unsymmetrical on chip both sides.
(2) What was considered as gradual increase or gradual decrease to the edge, without setting up the field used as width-of-face regularity of an edge.
(3) That to which aperture width increased gradually or dwindled only one side (usually high power light ejection (front end side) side) of an end face.
(4) That from which edge aperture width differs in respect of the front end and the back end.
(5) What combined some of above-mentioned (1) - (4).
[0077] Moreover, it is effective from a viewpoint of laser production of the diameter of a small spot in high dependability to reduce control of bulk degradation by the current impregnation to opening near the edge and the recombination current in an end face, as an electrode is not prepared near an end face.
[0078] If the die length of the aperture structure field in the direction of a resonator in an edge is too short, it will become difficult for repeatability to improve cleavage, and since loss by window region 40 will increase on the other hand if too long, degradation of a laser property, such as increase of a threshold current and reduction of slope effectiveness, will be caused. Then, as a minimum, the die length of window region 40 has desirable 1 micrometers or more, and its 5 micrometers or more are more desirable. As an upper limit, 50 micrometers or less are desirable and 30 micrometers or less are more desirable.

[0079] Although being formed in both ends is desirable as for window region 40, it may be formed only in the side face of one side. When formed only in one side, it is desirable to be formed in the end-face side to which outgoing radiation of the laser beam of high power is carried out more.
[0080] First, after forming the double hetero structure of having the 1st conductivity-type cladding layer 22, a barrier layer 23, and the 1st cladding layer 24 of the 2nd conductivity type on a substrate 21, the manufacture approach of the semi-conductor light device equipment of this invention forms the current block layer 26 on the 1st cladding layer 24 of the 2nd conductivity type, and forms opening 42 in the current block layer 26. Subsequently, after carrying out the ion implantation of the impurity to the both ends of opening 42, carrying out heat treatment and forming an aperture structure field, this current block layer 26 reaches opening 42, and the 2nd cladding layer 28 of the 2nd conductivity type is formed on the current block layer 26 of the 42 openings side at least.
[0081] Especially the crystal growth approach of each class in the manufacture approach of the semi-conductor light device equipment of this invention is not limited. Therefore, the approach from the former can be used, for example, the well-known growth approaches, such as metal-organic chemical vapor deposition (MOCVD law), a molecular beam epitaxy method (MBE law), a hydride or halide vapor growth (VPE law), and a liquid phase grown method (LPE law), can be suitably chosen as selective growth, such as crystal growth of double hetero structure, and a current block layer, and can be used for it.
[0082] Although the concrete growth conditions of each class etc. differ according to the configuration of the presentation of a layer, the growth approach, and equipment etc. When growing up a group-III-V-semiconducter layer using the MOCVD method, to double terrorism structure The growth temperature of about 600-750 degrees C, the V/III ratios 50-150 (it GaAs(es)) In InGaAs, it is 20 to about 60 (in the case of AlGaAs), and 300 to about 600 (it InGaAsP(s)). the case of AlGaInP -- a block layer -- the growth temperature of 600-700 degrees C, and a V/III ratio -- it is desirable to carry out by 40 to about 60 (in the case of AlGaAs) and 350 to about 550 (in the case of InGaAsP and AlGaInP).
[0083] As semiconductor laser equipment using the semi-conductor light device equipment of this invention the light source for information processing (usually -- an AlGaAs system (wavelength of about 780nm), and an AlGaInP system (wavelength band of 600nm) --) an InGaN system (wavelength of about 400nm), and the signal light source for a communication link (1.3-micrometer band which usually makes InGaAsP or InGaAs a barrier layer --) 1.5-micrometer band laser and the light source for fiber excitation (an InGaAs distortion quantum well barrier layer / GaAs substrate is used -- about 980nm) Busy equipments with which especially high power actuation is called for, such as semiconductor laser equipments for a communication link, such as laser, such as about 1480 etc.nm using an InGaAsP distortion quantum well barrier layer / InP substrate, can be mentioned. Moreover, circularly near laser is effective also by the laser for a communication link at the point which raises joint effectiveness with a fiber. Moreover, that whose far field pattern is a single peak can be offered as suitable laser for broad applications, such as information processing and optical communication.
[0084] Furthermore, this invention is applicable also as light emitting diodes (LED), such as an end-face luminescence mold, in addition to semiconductor laser. Moreover, this invention is applicable also as light emitting diodes (LED), such as an end-face luminescence mold, in addition to semiconductor laser.

[0085]
[Example] An example is given to below and this invention is further explained to a detail. The ingredient shown in the following examples, a reagent, a rate, actuation, etc. can be suitably changed, unless it deviates from the pneuma of this invention. Therefore, the range of this invention is not restricted to the example shown below.
(Example) In this example, semi-conductor luminescence equipment was manufactured by forming each class in the order shown in drawing 4 . In addition, although the part which is daring change the dimension is shown in drawing 4 in order to make structure easy to grasp, a dressed size is as being indicated in the following sentences.
[0086] the n mold GaAs (n=1x1018cm-3) substrate 101 top whose front face is a field (100) in 350

micrometers in thickness -- MBE -- by law n mold cladding layer 102, the GaAs optical confinement layer with a thickness of 30nm (non dope) which consist of n mold aluminum0.35Ga0.65As (Si dope: n=1x1018cm-3) with a thickness of 2.0 micrometers, An In0.2Ga0.8As well layer (non dope) with a thickness of 6nm, a GaAs barrier layer with a thickness of 8nm (non dope), The laminating of an In0.2Ga0.8As well layer (non dope) with a thickness of 6nm and the GaAs optical confinement layer (non dope) with a thickness of 30nm is carried out one by one. The becoming duplex quantum well A barrier layer 103, (DQW) p mold aluminum0.4Ga0.6As with a thickness of 0.1 micrometers (Be dope:) With a thickness [2.0 micrometers in the etching blocking layer 105 and thickness] it is thin from a p mold InGaP (Be dope: p=1x1018cm-3) layer of with p= 1x1018cm - a thickness [20nm in p mold cladding layer 104 which consists of 3, and thickness], and a p mold GaAs layer with a thickness of 10nm n mold aluminum0.4Ga0.6As (Si dope: The laminating of n mold current block layer 106 which consists of n=1x1018cm-3), and the n mold cap layer 107 which consists of an n mold GaAs with a thickness of 10nm (Si dope: n=1x1018cm-3) was carried out one by one.

[0087] In order to form a current impregnation field, first, the SiNx protective coat 108 with a thickness of 100nm was made to deposit on the front face of this double hetero substrate by plasma CVD, and much stripe-like openings were formed in the direction of [0-11] B with photolithography (drawing 4 (a)). In addition, the direction of [01-1] B is defined as the appearance whose field (11-1) which exists between fields (100) (01-1) is a field where V group element appears in a common group III-V semiconducter. Width of face of this stripe-like opening was fixed by 2.2 micrometers, and lateral tooth-space spacing was set to 500 micrometers. In opening of the shape of this stripe, as etching stopped by the 1st etching blocking layer 105, etching removed the cap layer 107 and the current block layer 106. The etching reagent used at this time was chosen from the tartaric acid / hydrogen-peroxide system, the sulfuric acid / hydrogen-peroxide system, the phosphoric acid / hydrogen-peroxide system, etc. (drawing 4 (b)). Then, the stripe-like SiNx film 108 was removed using the dry etching using gas, such as wet etching, such as buffer fluoric acid liquid, or SF6, CF4. Next, the SiNx protective coat with a thickness of 100nm was made to deposit on the front face of this double hetero substrate by plasma CVD, and the SiNx surface protective coat 109 of the shape of a rectangle which makes a longitudinal direction the direction of [0-11] B with photolithography was formed. The die length of the rectangle-like SiNx protective coat 109 set 980 micrometers and opening width of face to 40 micrometers (drawing 4 (c)).

[0088] Si ion was poured into the perimeter of this SiNx protective coat 109 with ion implantation equipment (drawing 4 (d)). Impregnation energy was set to 60eV or 120eV, and the dose was set to 1x1013cm-2 or 5x1013cm-2. About four samples from which an ion notes entry condition differs, the result of having measured PL peak wavelength ion-implantation before and after heat treatment is shown in Table 1.

[0089]

[Table 1]

サンプル	加速電圧 (keV)	ドーズ量 (cm^{-2})	PL波長 (nm)		シフト量 (nm)	プロファイル	
			ダブルヘテロ成長直後	イオン注入アニール後		ダブルヘテロ成長直後	イオン注入アニール後
A	60	1.00×10^{13}	965	966	1	図7	図8
B	120	1.00×10^{13}	962	949	−13	図9	図10
C	60	5.00×10^{13}	966	913	−53	図11	図12
D	120	5.00×10^{13}	964	946	−18	図13	図14

[0090] Impregnation energy was 60ev(s) and, as for the dose, 5x1013cm-2 were the more nearly optimal than this result. A dose [like] with to some extent high (about [6x1018cm -] 3) peak concentration is required for mixed-crystal-ized promotion, and this showed that mixed-crystal-ization was promoted more in the dose with more nearly same setting up impregnation energy so that a peak location may come to a front-face side for a while rather than a barrier layer. Moreover, drawing 7 -14 show the

profile immediately after double hetero growth of each sample, and after an ion implantation and annealing. The depth of an axis of abscissa shows the distance from etching blocking layer 105 front face of opening. In spite of having not spread the impregnation atom from these drawings to a barrier layer side in heat treatment after impregnation, it also turned out that mixed-crystal-ization takes place inside a barrier layer. Even if an impurity is not spread during heat treatment after an ion implantation from this, it is possible to make it mixed-crystal-ize. About mixed-crystal-ization, it checked by performing analysis of spatter Auger, a transmission electron microscope, etc.

[0091] Then, the SiNx protective coat 109 was removed using the dry etching using gas, such as wet etching, such as buffer fluoric acid liquid, or SF6, CF4. then, MOCVD -- the contact layer 113 which consists of a with a thickness [3.0 micrometers in the p type 2nd cladding layer 112 and, and thickness] it is thin with law from p mold aluminum0.4Ga0.6As (Zn dope: p=1x1018cm-3) with a thickness of 2.0 micrometers p mold GaAs (Zn dope: p=2x1019cm-3) was grown up.

[0092] Then, after vapor-depositing the electrode 114 by the side of p and making a substrate thin to 100 micrometers, the alloy of the n lateral electrode 115 was vapor-deposited and carried out (drawing 4 (e)). in this way, the produced wafer -- setting -- the impurity diffusion field of 40-micrometer width of face -- cleavage was mostly carried out in the center, it started to the chip bar so that a laser beam outgoing radiation end face might be formed (primary cleavage), and end-face aperture structure laser was produced. The cavity length at this time could be 1000 micrometers. Secondary cleavage separated into the chip, after performing unsymmetrical coating of 95% of 5%-back end sides of front end sides. After carrying out assembly of the chip by junction down, a current-optical output and the current-voltage characteristic were measured by continuation energization (CW) at 25 degrees C.

[0093] By the aperture structure laser produced by this example, the optical output increased with the increment in the operating current, and the optical output was obtained, without being a kink free-lancer and carrying out COD to about 600mW to about 450mW. However, even if it made the operating current increase more than it, the optical output did not increase but the optical output was restricted by the heat saturation by generation of heat of the component itself. Oscillation wavelength was [an average of 20mA and the slope effectiveness of an average of 976nm and a threshold current] an average of 0.85mW/mA, and the property was very good. Moreover, the perpendicular angle of divergence at the time of 250mW output was an average of 28 degrees, and the level flare angle was an average of 8.5 degrees. At this time, the astigmatic difference could be made very small with 2 micrometers or less, and it became clear that it became the light source excellent in the optical coupling property with an optical fiber. Furthermore, it became clear that high dependability (operational stability of 3000 hours or more in an elevated temperature (70 degrees C and 250mW) and high power) was acquired. Moreover, since opening for current impregnation was formed by etching to an etching blocking layer, the homogeneity of component structure could be raised and the above-mentioned semiconductor laser component was able to be produced by the high yield.

[0094] In addition, in the above-mentioned MOCVD method, the arsine and the phosphine were used for V group raw material, and hydrogen was used for carrier gas for trimethylgallium (TMG), trimethylindium (TMI), and trimethylaluminum (TMA) at the III group raw material. Moreover, the disilane was used for dimethyl zinc (DEZ) and n mold dopant at p mold dopant.

[0095] (Example of a comparison) Impurity diffusion by ion-implantation was not performed, but the laser component was produced according to the same process as an example 1 except for having not made the edge field into aperture structure. The laser components of this example of a comparison differ in that it does not have the impurity diffusion field in the example 1. By the laser of this component structure, when the operating current is made to increase, when about 350mW optical output was obtained, COD occurred, and the laser component has broken.

[0096]

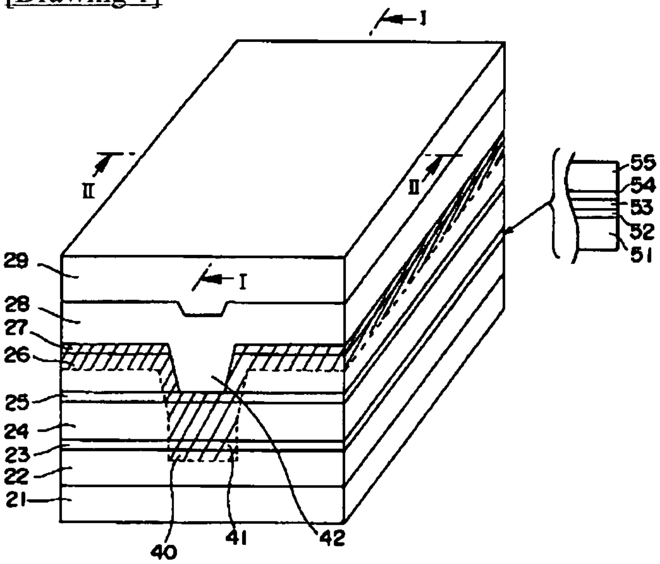
[Effect of the Invention] Since the semi-conductor luminescence equipment of this invention can control end-face degradation by making the edge of optical waveguide into aperture structure, it can raise the dependability of the component in high power actuation. For this reason, this invention is applied including extensive fields, such as semiconductor laser, and it deals in it, and is suitable for the light

source for optical-fiber amplifier excitation used especially for an optical transmission system.

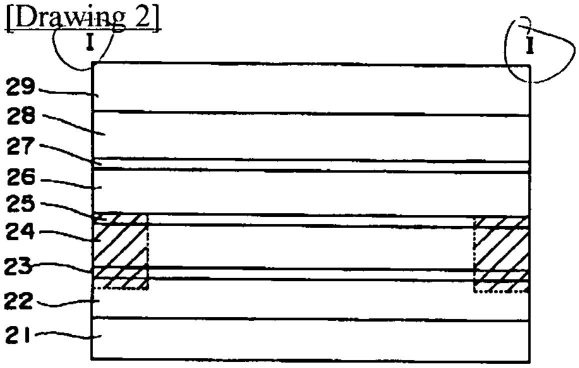
[0097] In case the semi-conductor luminescence equipment of this invention is manufactured, improvement in the position control nature of an impurity diffusion front and leakage current reduction in an edge can be aimed at by forming an impurity diffused layer in the nearby upper part at a barrier layer by using self aryne mold inner stripe laser structure as the base. Furthermore, this invention is effective in the case of laser production with an especially small mechanical design margin from the ability to raise the homogeneity of aperture width and produce the above-mentioned semiconductor laser component by the high yield.

DRAWINGS

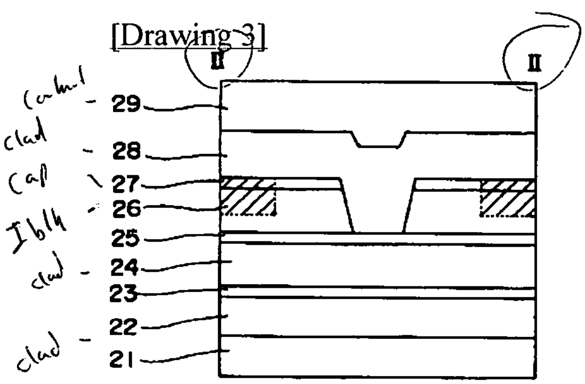
[Drawing 1]



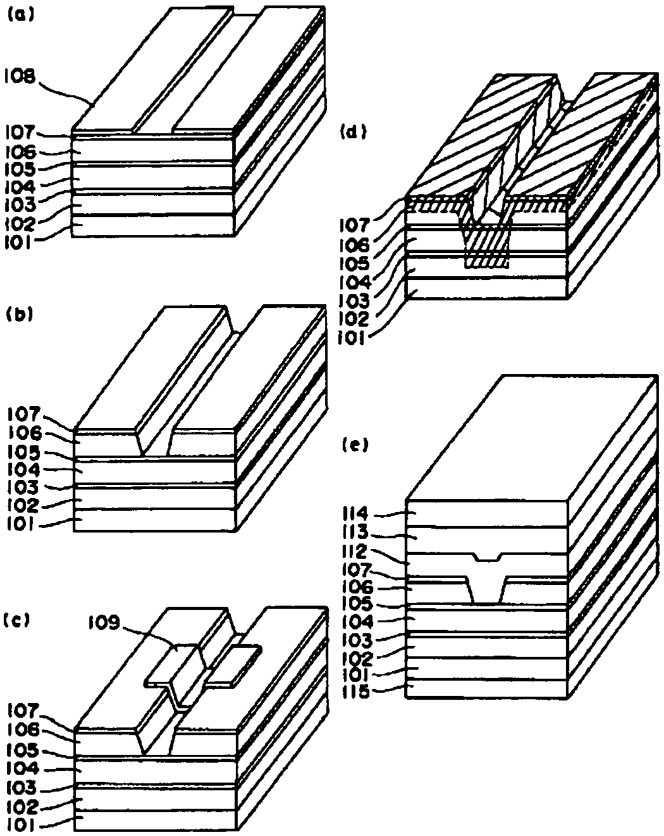
[Drawing 2]



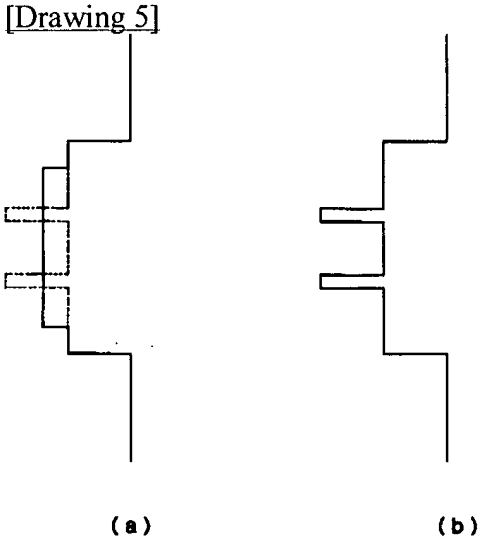
[Drawing 3]



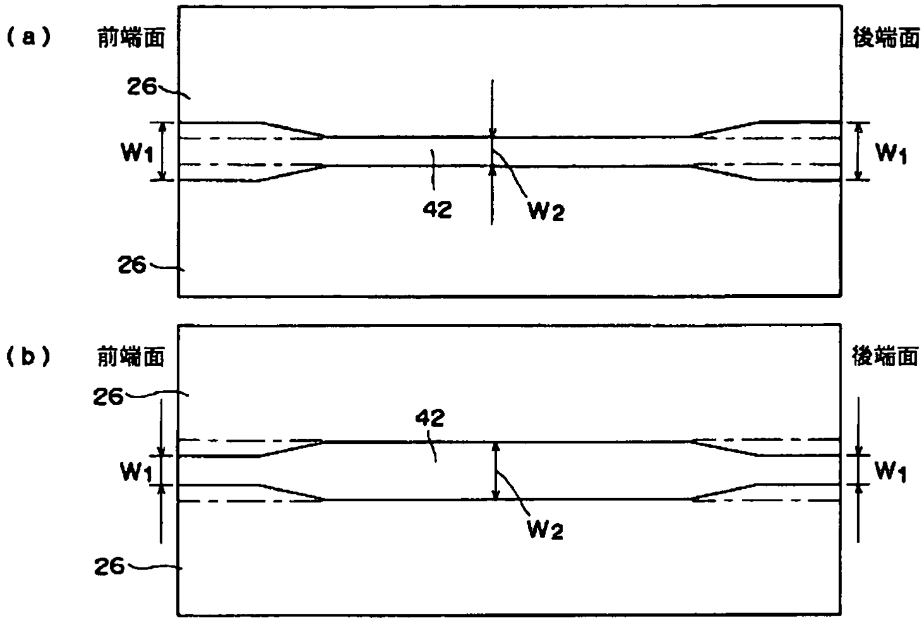
[Drawing 4]



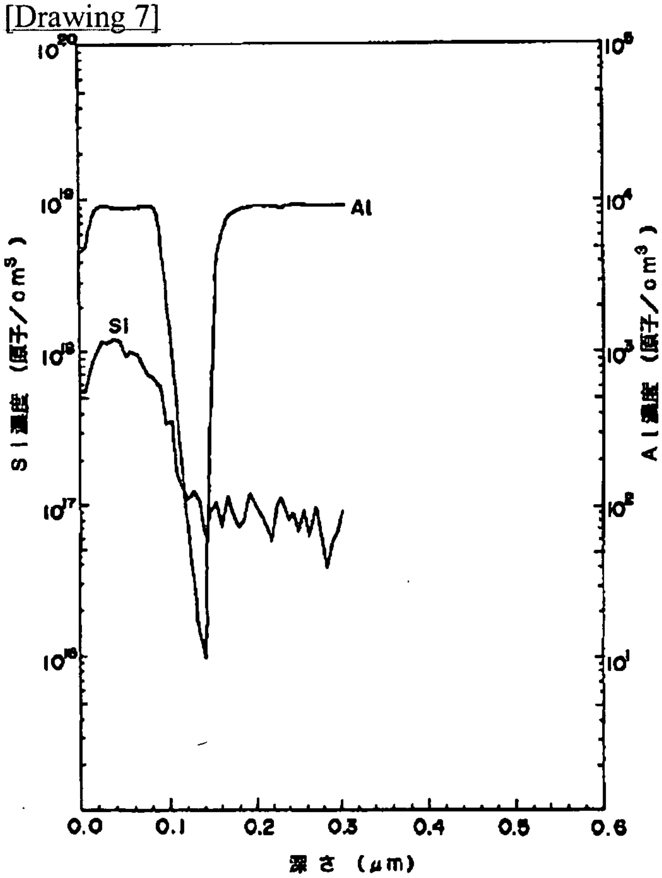
[Drawing 5]



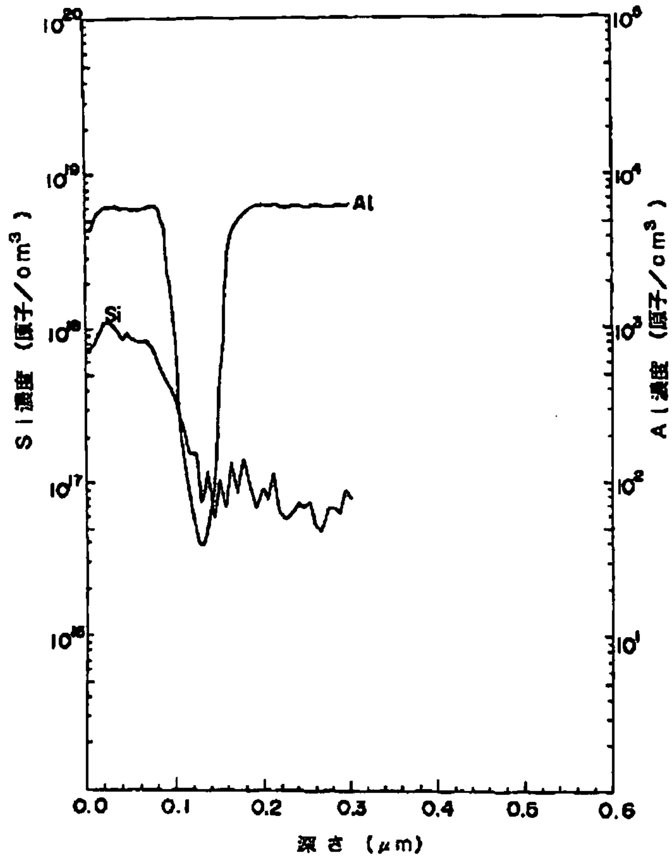
[Drawing 6]



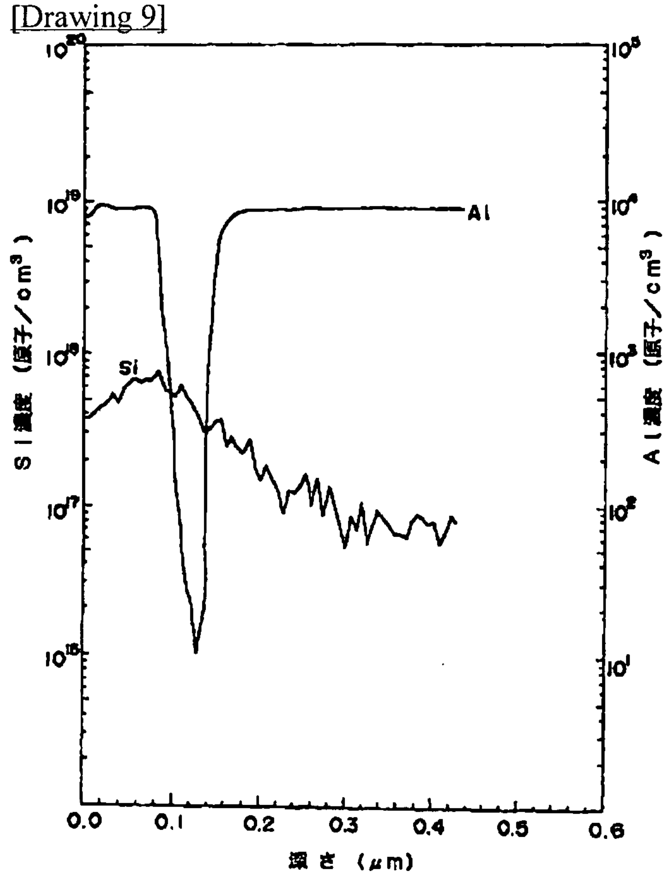
[Drawing 7]



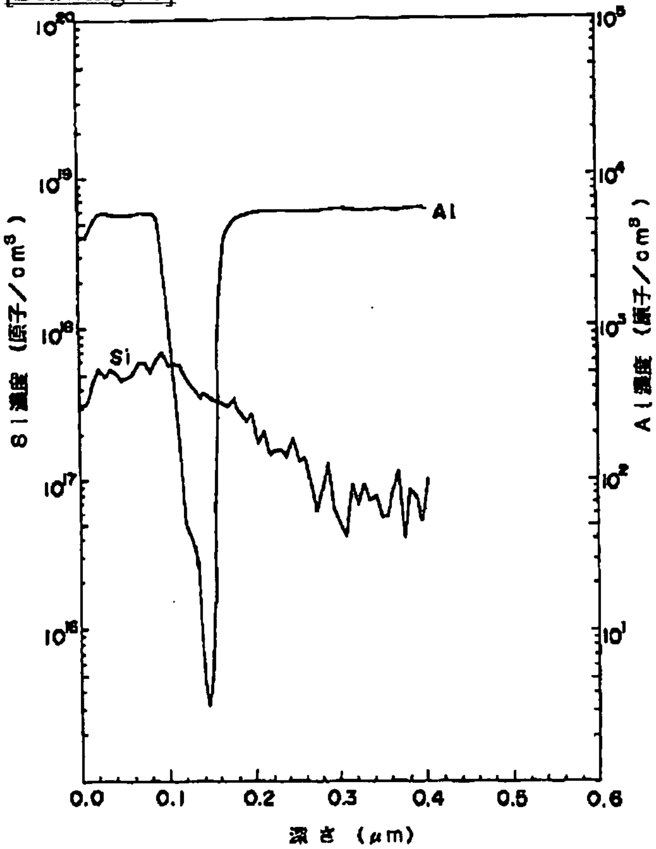
[Drawing 8]


10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
Al
Si
Si濃度（原子/cm^3）
Al濃度（原子/cm^3）
0.0 0.1 0.2 0.3 0.4 0.5 0.6
深さ（μm）

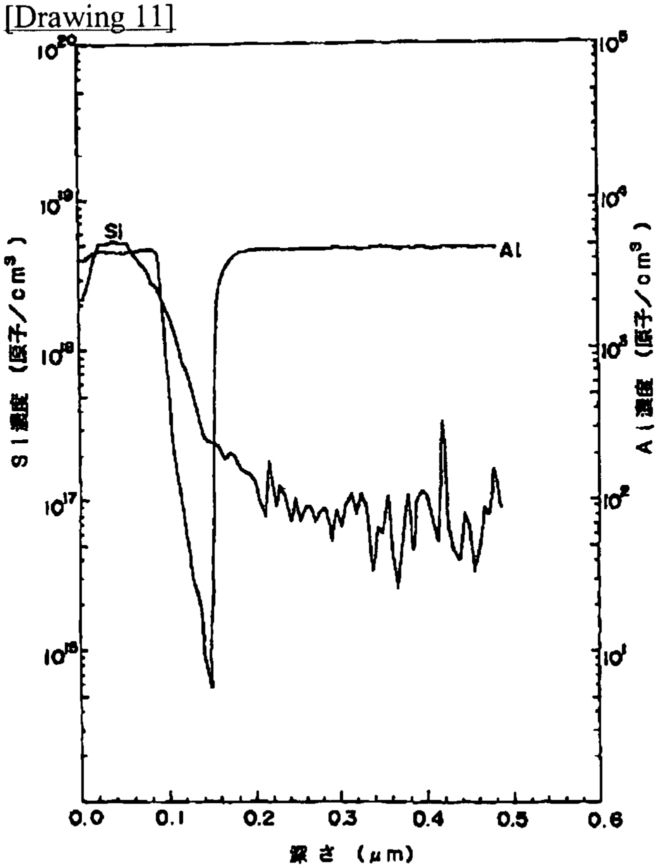
[Drawing 9]


10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
Al
Si
Si濃度（原子/cm^3）
Al濃度（原子/cm^3）
0.0 0.1 0.2 0.3 0.4 0.5 0.6
深さ（μm）

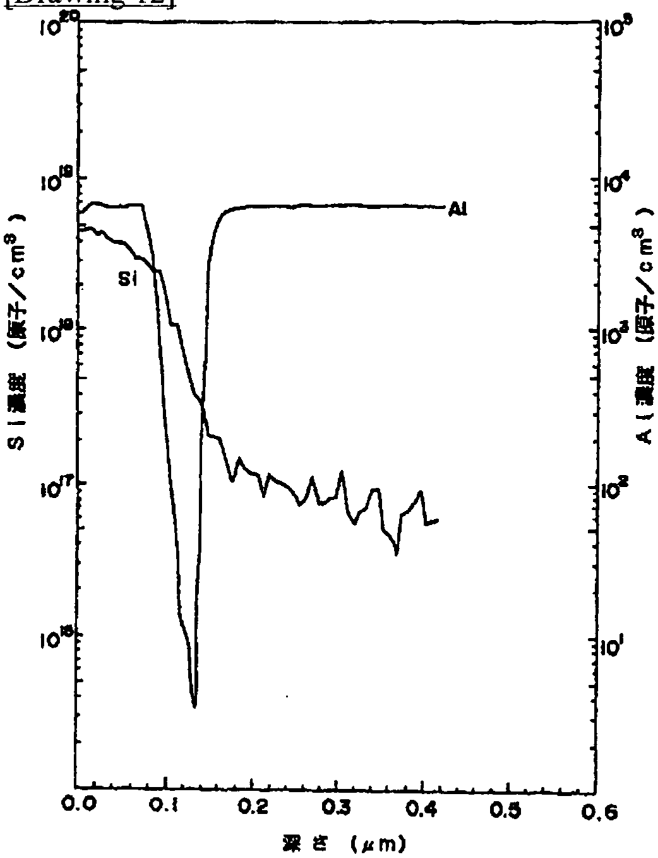
[Drawing 10]



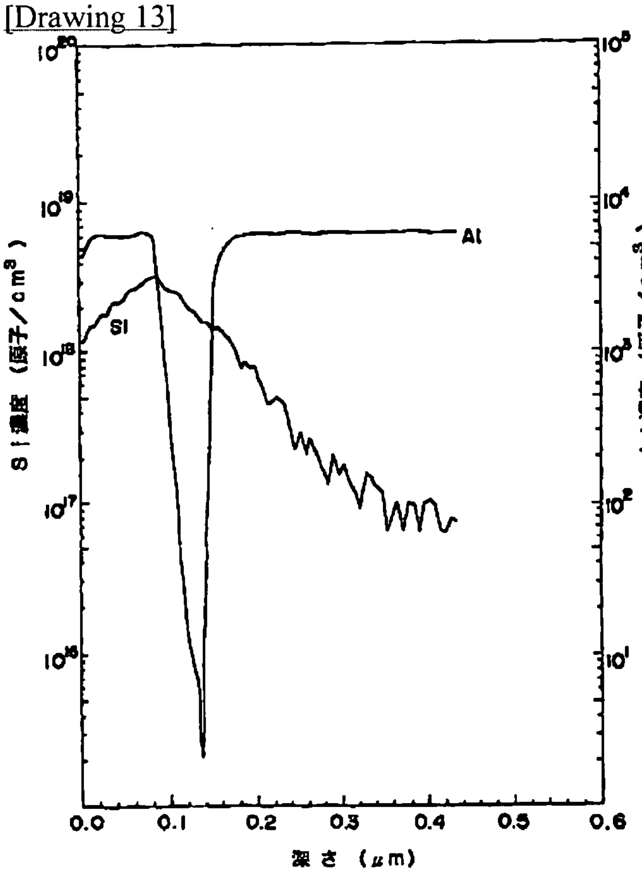
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Drawing 14]